Approved for public release; distribution unlimited.

THE INFLUENCE OF VISION ON SUSCEPTIBILITY TO ACUTE MOTION SICKNESS STUDIED UNDER QUANTIFIABLE STIMULUS-RESPONSE CONDITIONS

Wilhelmus J. Oosterveld, Ashton Graybiel, and D. Bryant Cramer

Order No. L-43518
Office of Advanced Research and Technology
National Aeronautics and Space Administration

17 November 1971

Released by

Captain N. W. Allebach, MC USN
Officer in Charge

Naval Aerospace Medical Research Laboratory
Naval Aerospace Medical Institute
Naval Aerospace Medical Center
Pensacola, Florida 32512

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY *(Corporate author)*

Naval Aerospace Medical Research Laboratory
Pensacola, Florida 32512

2a. REPORT SECURITY CLASSIFICATION

Unclassified

2b. GROUP

N/A

3 REPORT TITLE

THE INFLUENCE OF VISION ON SUSCEPTIBILITY TO ACUTE MOTION SICKNESS STUDIED UNDER QUANTIFIABLE STIMULUS-RESPONSE CONDITIONS.

4 DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

N/A

5 AUTHOR(S) *(First name, middle initial, last name)*

Wilhelmus J. Oosterveld, Ashton Graybiel, and D. Bryant Cramer

6 REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
17 November 1971	7	6

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
NASA Order L-43518	NAMRL-1149
b. PROJECT NO	
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10 DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11 SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Prepared for the National Aeronautics and Space Administration	

13 ABSTRACT

Twenty-four healthy men, 22 to 25 years of age, were exposed to stressful accelerations in a rotating room until acute mild motion sickness was elicited. Thirteen subjects in one group were exposed first with eyes open and later with eyes covered; the reverse order was used with the remaining eleven in the other group. The stressful accelerations were generated by requiring the subject to execute 120 standardized head movements at each 1-rpm increase in angular velocity until the desired endpoint was reached. This endpoint was 12 units on a scale where a score of 15 points represented the highest level of mild motion sickness and a score of 16, the lowest level of frank motion sickness. In the 48 experimental trials the average was 12.2 points when the endpoint was reached, and the range was 10 to 16 points. Thus, the terminal angular velocity required to achieve a given endpoint furnished a single value for comparing susceptibility between and among subjects; the range was 4 to 14 rpm.

When susceptibility to motion sickness with eyes open and covered is compared, 19 subjects were more susceptible with eyes open, three with eyes covered, and in the remaining two susceptibility was the same. The maximum difference in velocity between trial 1 and 2 was 7 rpm when susceptibility was greater with eyes open and 3 rpm when it was greater with eyes covered; the means, respectively, were 3.2 and 2.0 rpm. Among subjects manifesting greater susceptibility with eyes open than covered the group differences were small, indicating little or no adaptation effects. The findings are discussed mainly on the basis that vision may act also to decrease susceptibility under the stimulus conditions described.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

Unclassified
Security Classification

SUMMARY PAGE

THE PROBLEM

Twenty-four healthy men, 22 to 25 years of age, were exposed to stressful accelerations in a rotating room until acute mild motion sickness was elicited. Thirteen subjects in one group were exposed first with eyes open and later with eyes covered; the reverse order was used with the remaining eleven in the other group. The stressful accelerations were generated by requiring the subject to execute 120 standardized head movements at each 1-rpm increase in angular velocity until the desired endpoint was reached. This endpoint was 12 units on a scale where a score of 15 points represented the highest level of mild motion sickness and a score of 16, the lowest level of frank motion sickness. In the 48 experimental trials the average was 12.2 points when the endpoint was reached, and the range was 10 to 16 points. Thus, the terminal angular velocity required to achieve a given endpoint furnished a single value for comparing susceptibility between and among subjects; the range was 4 to 14 rpm.

FINDINGS

When susceptibility to motion sickness with eyes open and covered is compared, 19 subjects were more susceptible with eyes open, three with eyes covered, and in the remaining two susceptibility was the same. The maximum difference in velocity between trial 1 and 2 was 7 rpm when susceptibility was greater with eyes open and 3 rpm when it was greater with eyes covered; the means, respectively, were 3.2 and 2.0 rpm. Among subjects manifesting greater susceptibility with eyes open than covered the group differences were small, indicating little or no adaptation effects. The findings are discussed mainly on the basis that vision may act also to decrease susceptibility under the stimulus conditions described.

ACKNOWLEDGMENT

Grateful acknowledgment is extended to personnel of the Navy Medical Corps who assisted in carrying out this study.

Dr. Oosterveld's present address is University of Amsterdam, Amsterdam, The Netherlands.

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Vision						
Motion sickness						
Acceleration						
Rotation						

INTRODUCTION

There is general agreement that the vestibular organs are essential to the genesis of motion sickness and that vision is an important secondary etiological factor that tends to increase or decrease susceptibility, sometimes to a striking degree. Money (1) has recently reviewed the literature dealing both with the role of vision in the elicitation of motion sickness and with the elicitation of symptoms characteristic of motion sickness in the absence of motion, and it is apparent that 1) the independent role of vision in causing symptoms characteristic of motion sickness is small by comparison with that of the role of vestibular system, and 2) few ~~systemic~~ SYSTEMATIC studies have been conducted. The report to follow deals with the influence of vision on susceptibility to motion sickness in a slow rotation room (SRR) whereon the experimenter has excellent control over the stressful accelerations, and collaboration between subject and observers, in grading levels of severity of motion sickness, is facilitated.

Previous studies dealing with the influence of vision in the elicitation of motion sickness and involving slow rotation rooms fall into two categories. One involves vision and absence of vision under otherwise similar circumstances in the SRR and the other, a comparison of susceptibility (in the same subjects) with eyes open in the SRR and eyes covered when exposed to similar accelerative stimuli in rotating chairs. Among studies in the first category the most relevant (2) involved comparisons between blind and sighted subjects and comparisons in the latter group between eyes open and eyes covered. Significant differences in susceptibility between blind and sighted subjects (with eyes covered)were not found, but 10 of 12 sighted subjects were found to be more susceptible to motion sickness with eyes open than with eyes covered.

Although the main objective of studies in the second category was not a comparison between the subjects' susceptibility to motion in a rotating chair (with their eyes covered) and rotating room (with their eyes open), such comparisons may be made in studies where the subjects executed similar head movements in both devices (3,4). The findings show that considerably higher velocities of the chair (nearly twofold greater) were required to reach the endpoint, creating the impression that susceptibility was far higher with eyes covered than with eyes open.

PROCEDURE

SUBJECTS

Twenty-five healthy men, 22 to 25 years of age, served as subjects. Subjects participated only if they had been in their usual state of fitness for 7 days prior to testing, had not taken drugs (including alcohol) for at least 24 hours, and had not suffered from lack of sleep the previous night. There was one abort, however, in the experiment when one subject showed a sudden increase in severity of symptoms (avalanche phenomenon). This necessitated discontinuance of his tests, and he was excused from further participation, leaving 24 subjects who completed the study.

THE STRESS PROFILE

The stressful accelerations were generated by having the subject actively rotate his head (and body) out of the plane of the room's rotation. The head movements were executed while the subject was seated on a specially designed chair that had adjustable pads (front, back, left, and right) acting as "stops" limiting the head movements in four quadrants; in the present experiment the stops permitted head rotation through arcs of 90 degrees. Eight head movements, "bend" and "return," in the four quadrants were randomized, and a taped recording set the cadence at one movement every 2 seconds. The stress profile is shown in Figure 1. Beginning at 1 rpm, 120 head movements were executed at each incremental step of 1 rpm (with 60-second pauses between steps) until the desired endpoint was reached. The terminal velocity at endpoint was used as a score that measured interindividual and intraindividual differences in susceptibility to motion sickness.

THE MOTION SICKNESS ENDPOINT

The criteria used in estimating the levels of severity of motion sickness symptoms have been described in detail elsewhere (5). The endpoint chosen here was 12 points on a scale where 15 points represented the highest level of mild motion sickness and 16 points, the lowest level of frank motion sickness. The problem was to minimize undershooting or overshooting the endpoint, and this sometimes required a decision whether to "go" for the next higher rpm.

OPERATIONAL PLAN

Each subject was tested individually on two occasions separated by a period of at least two days. Group A (13 subjects) were exposed first with eyes open, then with eyes covered by an opaque patch; the order was reversed for the remaining 11 subjects (Group B). The only factor in selection was keeping the groups about equal in size. All of the instructions regarding the execution of head movements during the test were provided by playing the taped recording. During the 1-minute interval between steps there was ample opportunity to evaluate the motion sickness symptomatology.

RESULTS AND DISCUSSION

The results are summarized in Table 1. The endpoint was achieved in the 24 subjects within the range of 10 to 16 points, and the mean was 12.2 points. When susceptibility to motion sickness with eyes open and covered is compared, 19 subjects were more susceptible with their eyes open, 3 were more susceptible with their eyes covered, and in 2 susceptibility was the same under each condition. The terminal velocity at endpoint for the 24 subjects when their eyes were open ranged from 4 rpm to 14 rpm with a mean of 7.3, and, with eyes covered, ranged from 6 rpm to 13 rpm with a mean of 9.6 rpm. The mean difference between the two conditions was 2.3 rpm.

Group A contained the three subjects who manifested greater susceptibility with their eyes covered and Group B included the two subjects who manifested the same susceptibility with their eyes open and covered. Leaving these five subjects out of account, the group differences were very small, and there was no evidence of an order effect; i.e., the mean difference in rpm between trial 1 (eyes open) and 2 (eyes covered) for Group A was +3.2 rpm, and between trial 1 (eyes covered) and trial 2 (eyes open) for Group B was -3.1 rpm. The differences in rpm between trial 1 and 2 for the three subjects with greater susceptibility with their eyes covered were -1 rpm, -2 rpm, and -3 rpm. It is worth noting that these differences were exceeded in only 8 of 19 subjects manifesting greater susceptibility with their eyes open. The explanation is not to be found in lower endpoint scores; the largest individual difference was only 2 points on the scale. Subjects may differ in susceptibility from time to time, but if this explanation is used, then it also applies to the 11 additional subjects with differences in terminal velocity at endpoint between trial 1 and 2 no greater than 3 rpm. Even if we are dealing with intraindividual differences, which seems unlikely, the findings point to the need to look for unknown secondary etiological factors of greater significance than vision. If we are measuring mainly interindividual differences, then we cannot avoid invoking qualitative as well as quantitative differences in the role played by vision. A striking example of this curious behavior is seen in the changes in susceptibility that occur on transition into weightlessness (6), some persons becoming far more and others far less susceptible to motion sickness than under ground-based conditions.

CONCLUSIONS

The impression (2) that susceptibility to motion sickness with eyes open on the SRR was far higher than with eyes covered (chair) was not confirmed by the findings in the present study. The finding that five subjects (21 percent) either demonstrated the same or higher susceptibility with eyes covered than open receives a little support from the earlier study in the SRR when 2 in a group of 12 subjects were found to be more susceptible with eyes open than covered.

Elucidation of the role of vision in the elicitation of motion sickness is worth pursuing both from the practical and theoretical point of view. The highly standardized experimental conditions permitting quantification of stimulus and response in the present experiment took into account visual and vestibular factors, but subtle factors such as covert physiological, psychological, and even pathological factors still remain as possible, if minor, factors of etiologic significance.

Table I

The Effect of Vision on Susceptibility to Acute Slow Rotation Room (Motion) Sickness in 24 Young Healthy Men

	Group A						Group B					
	Exper. Trial 1 Eyes Open			Exper. Trial 2 Eyes Covered		Diff. in rpm trial 1 & 2	Exper. Trial 1 Eyes Covered			Exper. Trial 2 Eyes Open		Diff. in rpm trial 1 & 2
	Subj. No.	RPM at Endpoint	MS Score	RPM at Endpoint	MS Score		Subj. No.	RPM at Endpoint	MS Score	RPM at Endpoint	MS Score	
Susceptibility greater with eyes open	1	5	12	9	10	+4	4	9	10	7	14	-2
	3	6	10	7	12	+1	5	9	13	7	13	-2
	6	7	12	9	11	+2	8	12	12	8	15	-4
	7	8	13	11	13	+3	9	6	12	5	13	-1
	10	7	13	11	13	+4	11	12	15	7	15	-5
	12	5	13	12	12	+7	14	12	14	8	13	-4
	13	4	14	8	14	+4	15	9	13	6	14	-3
	18	5	11	8	16	+3	19	12	13	9	13	-3
	20	11	14	13	13	+2	24	9	13	5	12	-4
	21	10	13	12	14	+2	(9 Ss)	av. 10.0		av. 6.9		av. -3.1
	(10 Ss)	av. 6.8		av. 10.0		av. +3.2						
Susceptibility greater with eyes covered	2	6	12	4	12	-2	17	7	11	7	11	0
	16	14	12	13	12	-1	23	9	14	9	15	0
	22	10	14	7	16	-3	(2 Ss)	av. 8		av. 8		
	(3 Ss)	av. 10		av. 8		av. -2	11 Ss	av. 9.6		av. 7.1		av. -2.5
	13 Ss	av. 7.5		av. 9.5		av. +2						
Susceptibility same under both conditions												

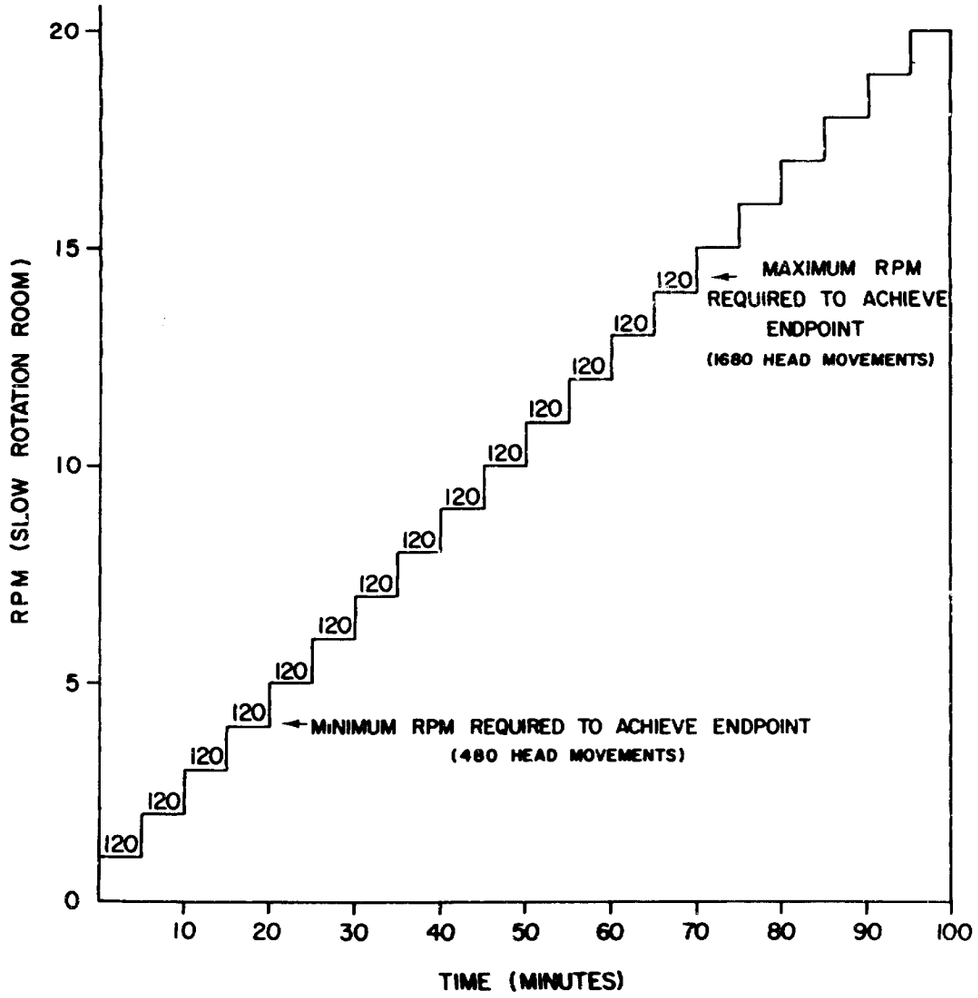

Figure 1

Stress profile used in testing motion sickness susceptibility of the 24 subjects. 120 = number of head movements made in four quadrants at each step increase in velocity of the room. Endpoint was 12 units on a scale used in grading severity of motion sickness (5).

REFERENCES

1. Money, K. E., Motion sickness. Physiol. Rev., 50:1-39, 1970.

2. Graybiel, A., Susceptibility to acute motion sickness in blind persons. Aerospace Med., 41:650-653, 1970.

3. Miller, E. F. II, and Graybiel, A., The semicircular canals as a primary etiological factor in motion sickness. In: The Role of the Vestibular Organs in Space Exploration. NASA SP-187. Washington, D. C.: U. S. Government Printing Office, 1970. Pp. 69-82.

4. Miller, E. F. II, and Graybiel, A., Motion sickness produced by head movement as a function of rotational velocity. Aerospace Med., 41:1180-1184, 1970.

5. Graybiel, A., Wood, C. D., Miller, E. F. II, and Cramer, D. B., Diagnostic criteria for grading the severity of acute motion sickness. Aerospace Med., 39:453-455, 1968.

6. Miller, E. F. II, Graybiel, A., Kellogg, R. S., and O'Donnell, R. D., Motion sickness susceptibility under weightless and hypergravity conditions generated by parabolic flight. Aerospace Med., 40:862-868, 1969.